

Description FR2835056

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The present invention relates to a process and a device for measuring the level of liquid in a tank. It applies, in particular, the level measurement of oil in the oil tank of a motor vehicle with a sensor-type "hot wire".

The level measurement of oil "hot wire" is to have in the oil tank, a resistive wire immersed whose length depends on the oil level in the tank or crankcase. It applies to the wire constant current  $I_c$  for a period  $dt$  and measure the tension  $U_s$  in the terminal wire, before the application of constant current,  $U_{s0}$ , and after application of this trend during the period  $dt$ ,  $U_{sdt}$ . As a result of the rise in temperature due to the Joule effect, particularly on the iceberg wire, resistance wire and varies the voltage  $U_s$  is changing for the duration  $dt$ , depending on the level of oil in the tank.

The documents FR 86 08 056, EP 249521 and U.S. 5272, 919 expose various achievements of devices for measuring the level of oil using this principle.

The implementation of the principle outlined above implies a cost and complexity of implementation due to the need to generate a constant flow with great accuracy (about one per cent).

This invention is designed to remedy these problems by subjugating the average current in the wire resistive by using a generator current variable duty cycle and a probe measuring average current generated by the generator.

To this end, the present invention relates to a device for measuring the level of liquid in a tank containing an electrical conductor on resistive thermal contact with the liquid over a length that varies with the level of liquid in the tank, characterized in that it includes: - a measure of current placed in series with the resistive electrical conductor and providing a signal representative of current through the electrical conductor - a generator current variable duty cycle, which applies a current ratio cyclical variable that Measuring resistance in series with the resistive electrical conductor, for a predetermined period  $dt$ ,

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-- A means of enslavement of the current cyclical report issued by the current generator, according to the signal provided through current measure, and - a circuit level measurement oil terminals connected to the electrical conductor resistive.

With these provisions, the average current through the electrical conductor resistive is precisely controlled, without the power being used is costly or

complex.

According to special characteristics, a measure of current resistance is a precision, the signal provided through current measure is the voltage across the resistance.

With these provisions, the current measurement is easy and not very sensitive to the signals.

According to special characteristics, the circuit measure is associated with an analog-digital converter connected to the terminals of an electrical conductor, said converter providing a digital signal representative of the voltage electrical conductor said resistive and includes a microprocessor receiving the digital signal. With these provisions, enslavement can be achieved by a microprocessor of a calculator of the vehicle that provides other processing functions in the vehicle.

According to special characteristics, a way of enslavement includes a second analog-to-digital converter providing a digital signal representative of the voltage across the resistance measurement and a microprocessor receiving the digital signal and Commander, depending said digital signal, the report cyclical current issued by the generator.

With these provisions, the treatment of tension at the beginning and end of time interval  $dt$  time to get a measure of the oil level in the reservoir can be achieved by a microprocessor of a calculator of the vehicle which ensures d ' other processing functions in the vehicle.

According to a second aspect, this invention relates to a process of measuring the level of liquid in a tank, implementing an electrical conductor on resistive thermal contact with the liquid over a length that varies with the level of liquid in the tank, characterized in that it includes:

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-- A step enslavement of a duty cycle of a current through the electrical conductor resistive, for a period  $dt$ , according to a signal provided by means of current measure placed in series with the resistive electrical conductor, and -- A stage measuring oil level according to an evolution of a terminal voltage electrical conductor said.

The particular characteristics and advantages of this process are identical to those of the device briefly outlined above, they are not mentioned here.

Other advantages, goals and characteristics of this invention emerge from the description which will follow made against the drawings in which: - Figure 1 represents a device using a particular realization of this invention and Figure 2 represents a diagram of temporal variation of tension.

In Figure 1, a device measuring 10 fluid level includes a generator current

duty cycle variable 11, a resistance measurement 12, an electrical conductor resistive 13, which crosses the free surface of a liquid 14 in a reservoir 15. A circuit enslavement current 16 terminals connected to the resistance measurement 12, a first analog-to-digital converter 17 terminals connected to the electrical conductor resistive 13 and a circuit for measuring liquid level 18.

The current generator at variable duty cycle is 11 type known. The current duty cycle is controlled by the circuit enslavement 16. The resistance measuring 12 is a resistance precision, whose resistance is known to prefer less than two per cent.

The electrical conductor resistive type 13 is known in applications to measure the level of liquid "hot wire". Also, the electrical conductor resistive 13, preferably a high temperature coefficient, ie that its resistance varies sharply with its temperature. The overall resilience of the electrical conductor resistive 13 depends on the relationship between the lengths of part of the electrical conductor resistive 13, which is submerged, and is therefore cooled by the liquid, and the iceberg, less cooled than the submerged.

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The circuit enslavement current 16 includes a second-analog converter 19 terminals connected to the resistance measuring 20 and a microprocessor that receives the second analog-to-digital converter 19 a digital signal representative of the voltage of electrical conductor resistive 13 and implements a programme of enslavement so that the intensity of current average applied during the measure is an average intensity predetermined, regardless of engine temperature and / or oil in the crankcase.

The first digital-analog converter 17 provides a digital signal representative of the voltage of electrical conductor resistive 13. The circuit measuring liquid level 18 includes a microprocessor 21 implementing a program to measure oil level in light of changing the voltage of electrical conductor resistive 13, according to algorithms known.

When, for a period  $dt$ , the current generator to report cyclical variable 11 applied to the electrical conductor resistive current 13 whose average intensity is predetermined, temperature, the overall resilience of the electrical conductor resistive 13 and the voltage driver 13 electric resistive change depending on the level of oil in the crankcase. The initial tension is rated  $Us_0$  and tension at the end of the period is noted  $Us_{dt}$   $dt$ . For treatment of values  $Us_0$  and  $Us_{dt}$ , the circuit level measurement of liquid 18 determines the oil level and transmits the oil level measured at a computer (not shown) of the vehicle which treats the oil level, for example, trigger the issuance of a visual signal on the dashboard, for example, by lighting a warning or display a symbol.

We understand that with the implementation of this invention, the average intensity of the current running through the electrical conductor resistive 13 is known in advance, with a precision which depends on the accuracy of the value of resistance Measuring 12. Thus, depending on the change in the voltage of electrical conductor resistive 13, it measures the height of liquid in the crankcase with an accuracy equivalent to the accuracy of the value of the resistance is 12.

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Alternatively, the microprocessor 20 and microprocessor 21 are combined into a single microprocessor implementing a program to measure oil level and the programme of enslavement.

There is, in Figure 2, the evolution of different signals implemented in the device shown in Figure 1, during the time interval duration  $dt$ , is, from top to bottom: - signal 22 command cyclical report issued by the circuit enslavement current 16, - the intensity of the 23 current supplied by the generator current duty cycle variable 11 - 24 tension at the terminals of resistance measurement 12, - the tension average of 25 the bounds of resistance measuring 12 since the beginning of the time interval duration  $dt$ , and - the tension 26 at the terminals of an electrical conductor resistive 13.

For the sake of simplicity, it was considered in Figure 2 that the time interval  $dt$  consisted of three phases successives  $P1$ ,  $P2$  and  $P3$ , on equal terms, the signal 22 command duty cycle can not change between two phases Successive. However, in reality, the command signal enslavement can vary quite frequently, for example in each cycle generator current 11.

It observes that periods of alternating signal 22 command duty cycle and intensity of the 23 current supplied by the current generator 11 are not at the same time scale as the other curves, the duration of a cycle being preferentially by several orders of magnitude shorter than the duration  $dt$ . Thus, for each phase of the measure, the tension 24 is practically a linear curve as shown in Figure 2.

Tension 24 at the terminals of resistance measuring 12 is proportional to the intensity of the 23 current supplied by the current generator 11, in accordance with the law Joule.

By overlaying the tension with the average of 25 terminals resistance measurement 12, on a reported average voltage reference to the 27 terminals of the resistance measurement 12, which corresponds to the average intensity of the predetermined course that aims to provide the electrical conductor resistive 13.

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The purpose of the device is enslavement at the end of the time interval  $dt$ , with the average current through the electrical conductor resistive 13 is as close as possible to predetermined average intensity that corresponds to the average voltage reference 27: The average reference voltage 27 is the product of the average intensity predetermined by the resistance of the resistance is 12.

It notes that at the beginning of time interval  $dt$  and duration of the phase  $P1$ , the signal command duty cycle has a predetermined value which may depend on the value of duty cycle used during the previous measurement period. In this example, the duty cycle is one half.

As illustrated in Figure 2, it is assumed that in the first phase  $P1$ , tension average of 25 exceeds the reference voltage 27. In this  
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If at the end of phase  $P1$ , the circuit enslavement 16 reduces the duty cycle applied by the generator 11 by reducing the value of signal 22 command duty cycle.

Thus, during the  $P2$  phase, the duty cycle is reduced compared to the duty cycle implemented during the phase  $P1$ , tension average of 25 terminals of the resistance measuring 12 decreasing gradually.

As illustrated in traits interrupted in Figure 2, it is assumed that in phase  $P2$ , the gradual decrease of tension average of 25 is, in absolute terms, than what corresponds to a convergence of tension average of 25 to the reference voltage 27. In this case, the end of phase  $P2$ , the circuit enslavement 16 increases slightly the duty cycle applied by the generator 11 in slightly increasing the value of signal 22 command duty cycle.

Thus, during the phase  $P3$ , the duty cycle is reduced compared to the duty cycle implemented during the phase  $P2$ , tension average of 25 terminals of the resistance is 12 but gradually decreasing at a rate of decrease lightest as the  $P2$  phase.

Thanks to enslavement, made here in two stages, the tension average of 25 terminals of resistance measurement is at the end of phase  $P3$  equal or substantially equal to the reference voltage 27, which means that

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the average intensity of the current driver who crossed the electric resistive 13 is substantially equal to the intensity predetermined.

Thanks to the precision with which the average intensity of the current is controlled, values initial  $Us0$  (at the beginning of time interval  $dt$ ) and

final  $U_{sdt}$  (at the end of the time interval  $dt$ ) of the voltage driver's electrical resistive 13 represent precisely the amount of liquid 14 in the reservoir 15.

The function of enslavement of the duty cycle the voltage difference between the average 25 and the reference voltage 27 is selected to ensure a rapid convergence between these two strains, during the time interval  $dt$ .

As known in the field of automation, convergence can be gradual, without crossing the final value or oscillate around this final value.

It is observed that the tension averaged 27 may depend on the temperature of the oil in the crankcase, through the implementation of a temperature sensor unrepresented.

Although throughout the description, measuring the average intensity of current through the electrical conductor resistive 13 is made with a resistance measurement 12, a variant, it is implementing other means of current measure, for example means sensitive to magnetic fields generated by the passage of this current through an electrical conductor placed in series with the electrical conductor resistive 13

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